Compost Research for Landscape Applications

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1) Many landscaped sites have soils or substrates that are degraded, creating harsh conditions and sparse plant growth.

2) Sparse plant cover is erosive, unattractive and often weedy.

3) Composts are a common amendment on degraded sites.

4) Research at the Soils and Revegetation Lab at UC Davis focuses on understanding effects of organics in soils, and how they improve plant growth conditions on harsh sites and degraded substrates.

Compost Research for Landscape Applications

(problem statement)

Compost use needs to be beneficial under a range of site conditions and project objectives:

1) Composts differ (all safe, but sizes, blends and curing differ).

2) Site conditions differ (compacted soils, excavated materials, irrigated or natural xeriscapes, road edges, hot south slopes).

3) Objectives differ (durable turf cover, walkable trails, erosion control, habitat conservation, landscaped plantings, weed control, micro-climate modification).

Compost Research for Landscape Applications

(research goals)

But the objectives of compost use are always the same:

1) help plants grow better for improved site performance and

2) make application of these materials safe and dependable enough to increase use.

These two objectives should make it easier for routine compost utilization to be ‘green’

Compost Research for Landscape Applications

(research objectives)

The two most common ways that
plant growth can be improved on degraded sites are by:

1) improving plant available moisture and

2) providing balanced nutrient availability.

<u>Plant available moisture</u>

is defined as the moisture that is left in the soil between <u>drainage</u> (after a storm or irrigation event) versus <u>plant wilting</u> (when plants can extract no more moisture).
(a.k.a. Field Capacity minus Permanent Wilting Point)

If there is not enough drainage: the roots stay wet and they can drown or rot

If there is too much drainage, or too little water is retained after drainage: the plant grows less and may dry out and die before the next rain or irrigation.

Finding:

Incorporation of coarse woody fragments (compost overs, tub ground shreds, chipped wood fragments) increases drainage in compacted substrates immediately after incorporation and keeps drainage pores open until plant roots get established. Fine compost doesn’t work as well as woody fragments.

Example treatment:

Roughly incorporate an inch of woody fragments into the top foot to create a storm-resistant soil out of a compacted substrate. Don’t mix too finely because the amended soil will set up like a brick when rewetted. Deeper drainage allows longer lasting storms to be infiltrated without runoff. Adequate infiltration captures enough winter rain for plant growth through the summer without irrigation in most areas of the state.

Finding:
In damp soils (near Field Capacity), fine (< 3/8 inch screen) composts can hold more water and improve seed germination and growth of mesic (non-drought tolerant) horticultural plants.

Example treatment:
Composts used for improving plant growth should be cured after thermophilic composting to increase nutrient release for seedling growth. Recommended compost depths depend on ambient soil fertility but a common wildlands application on sterile, low organic matter soils is an inch layer or less.

Finding:

In droughty soils, fine (< 3/8 inch screen) composts can decrease moisture availability and decrease plant growth from similar volumes of soil. However, the root growth of plants is often improved enough that larger soil volumes are explored, creating a positive net effect.

Example treatment:

Xeriscape plantings and wild land plantings should not have large applications of fine compost because of reduced moisture availability late in the season . A thick mulch and deeper rooting volume (fractured substrate to 3 feet, 10 % woody shred incorporation) is more useful than a compost amendment to the surface soil layer.

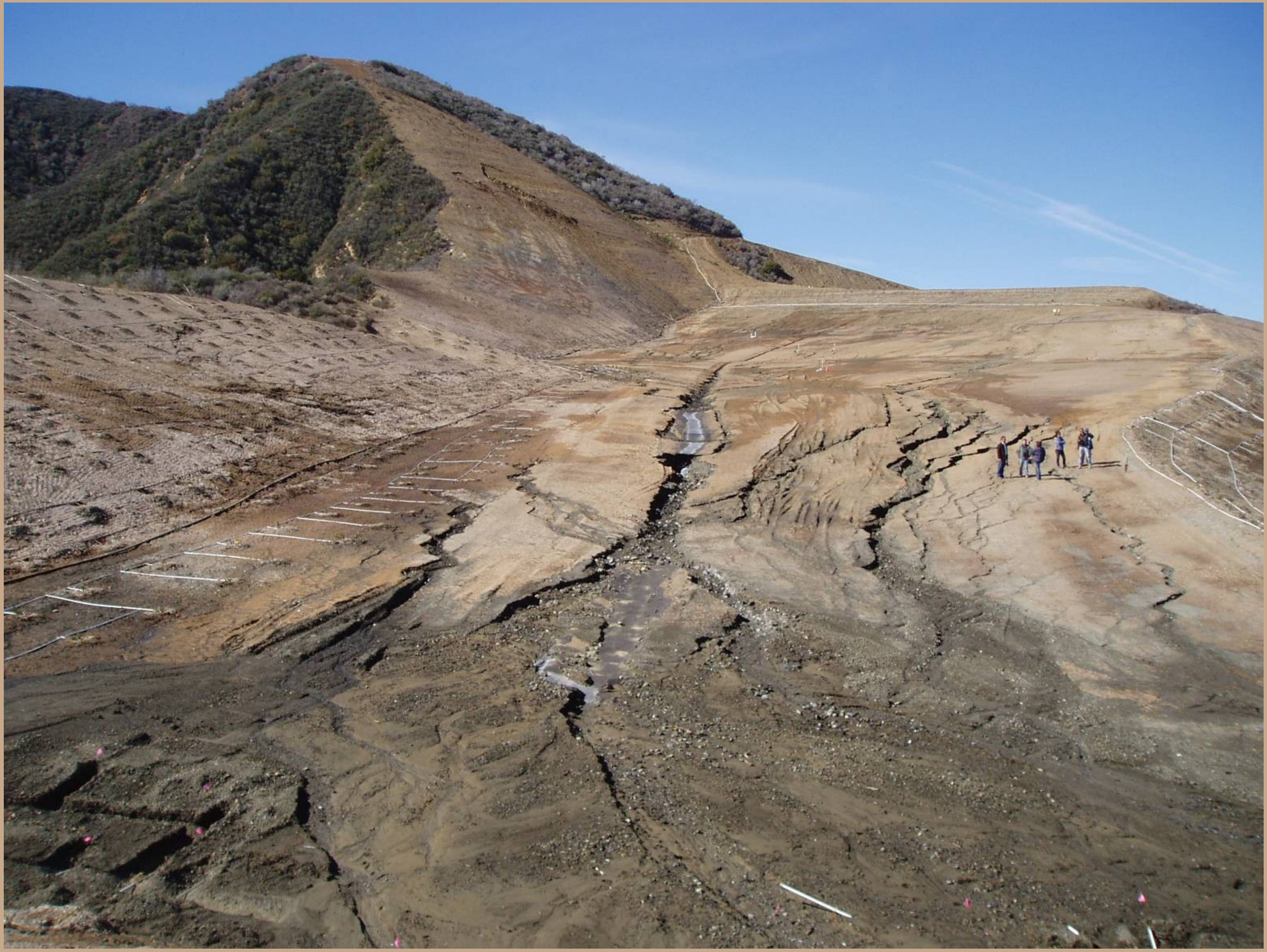
General conclusion on amendments for drainage:

Fine composts hold additional water in wet conditions, but they actually hold less water when the soils dry out, except for sandy soils. For drought-tolerant plantings, make sure that the soil is rootable (fractured) to about 3 feet, and use wood fragments to keep tilled soils open until roots establish. Compost amendment, especially with woody fragments, also helps increase infiltration. Finish with a woody mulch. Fine compost can then be used to balance nutrient availability (next section).

For example, this sandy soil should have good drainage, but infiltration is very low because organic matter content and soil aggregation are low. The next slide shows how deep irrigation water got after 1 hour of soaking.

After 1 hour of soaking on this sandy soil, only 3 inches of infiltration occurred. This soil will generate runoff and erosion from most storms. Organics break up compacted or close packed substrates and improve infiltration

This site had adequate infiltration of the soil surface, but the depth to an impermeable rock layer was too shallow. As a result, a storm generated overland flow and mobilized sediment from the slope.



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In addition to reduced erosion from slopes with shallow soils, deeper rooting depths also improve plant growth. This “J” rooted plant can only maintain a small canopy and leaf area because rooting depth is restricted and summer moisture availability is low.

Ripper shanks open up substrates for improved infiltration. Wood shreds are needed to keep the fractures open on some substrates until plant roots establish. But, organics are not incorporated very deeply by conventional equipment.

Nutrient availability

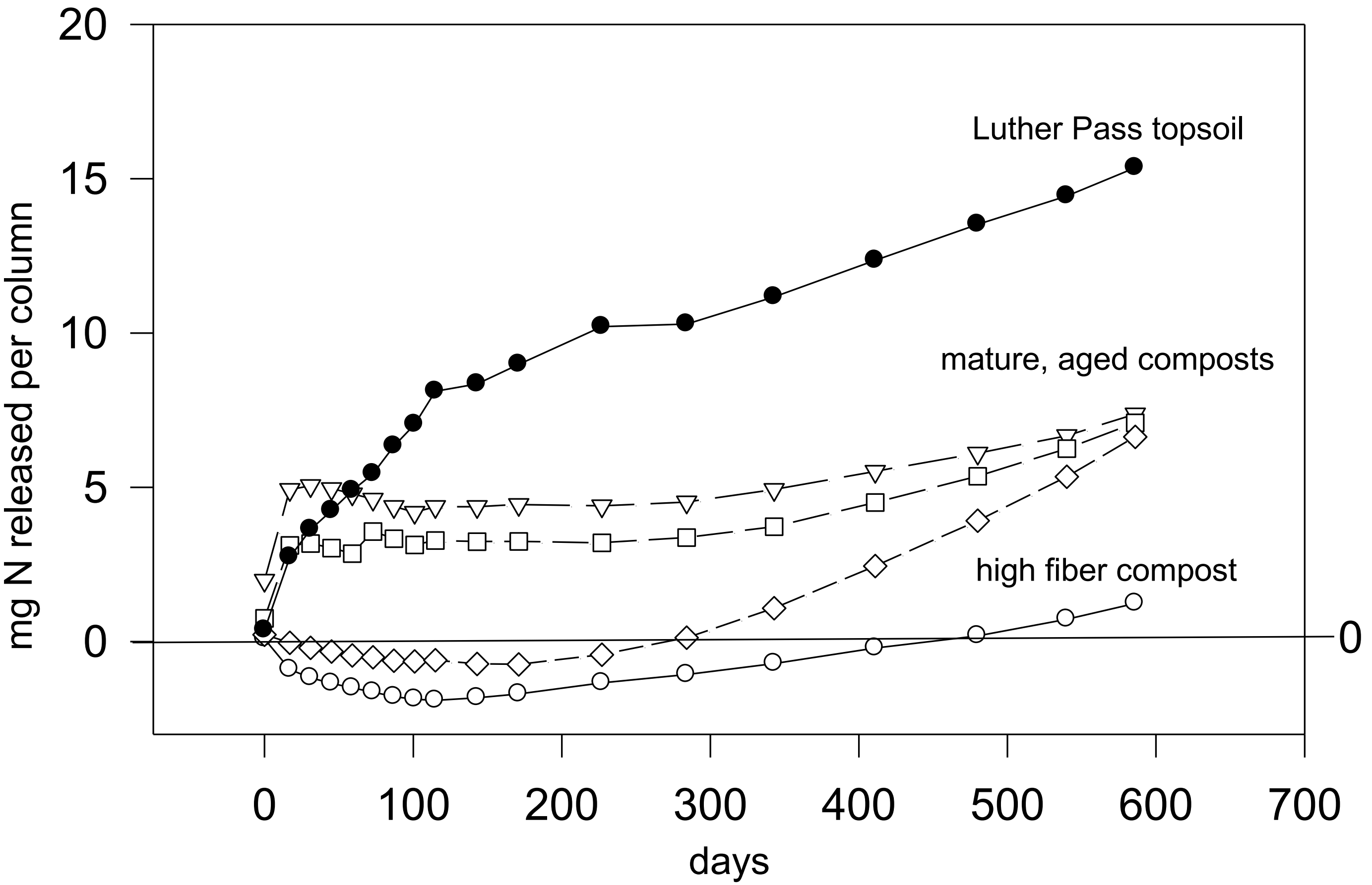
The second common way that composts improve plant growth is through balanced plant nutrient availability.

Because yard waste composts are generated from plant materials, the proportions of nutrient released are appropriate for plant growth. But, composts that have not been well cured after thermophilic processing can still immobilize nitrogen as their decomposition continues in soil conditions. For this reason, a several month period of curing is useful for rapid release of nutrients for plant growth.

All these composts have the same total N content, but N release varies. The smaller plants are from composts with less curing time. The far left yard waste compost was blended with biosolids.

Finding:

The pots with the smallest plants came from the uncured (high fiber) composts, while the plants with yard waste compost that was cured several months after thermophilic processing grew larger. The biosolids blend (left pots) is not shown on this graph.



Nitrogen yield (mg N per column) during a 586 day aerobic incubation of topsoil from Luther Pass in the Tahoe Basin and decomposed granite sands receiving amendments (500 kg N/ha) of various composts.

The previous slide shows a graph of nitrogen yield during a 586 day aerobic incubation of topsoil from Luther Pass in the Tahoe Basin and decomposed granite sands receiving amendments (500 kg N/ha) of various composts.

- y-axis: milligrams nitrogen release per column from 0 to 20
- x-axis: from 0 to 700 days
  - Luther Pass topsoil had steeply increasing rates of nitrogen release up to a peak of 15 at the end of incubation
  - Mature, aged composts had gradually increasing rates of N release over the experiment with a peak of approximately 7 at the end of incubation.
  - High fiber composts had close to 0 N release during the entire experiment with a final N release of about 1

An urban installation of compost to improve plant growth is shown in these photos (before treatment) from a bare cut slope at Hwy 85 x 17 in San Jose, CA.

arrows show direction of view in other photo

Plot treatments

1) no irrigation
2) different tillage depths (0, 1.5 and 3 feet)
3) amendment (none, compost, inorganic moisture retainer)
4) organics were incorporated or applied as a surface mulch
5) all plots with weed mat, needlegrass and coyote bush

First season growth: all plants are small, as commonly occurs in native species, which emphasize root growth in the first year.

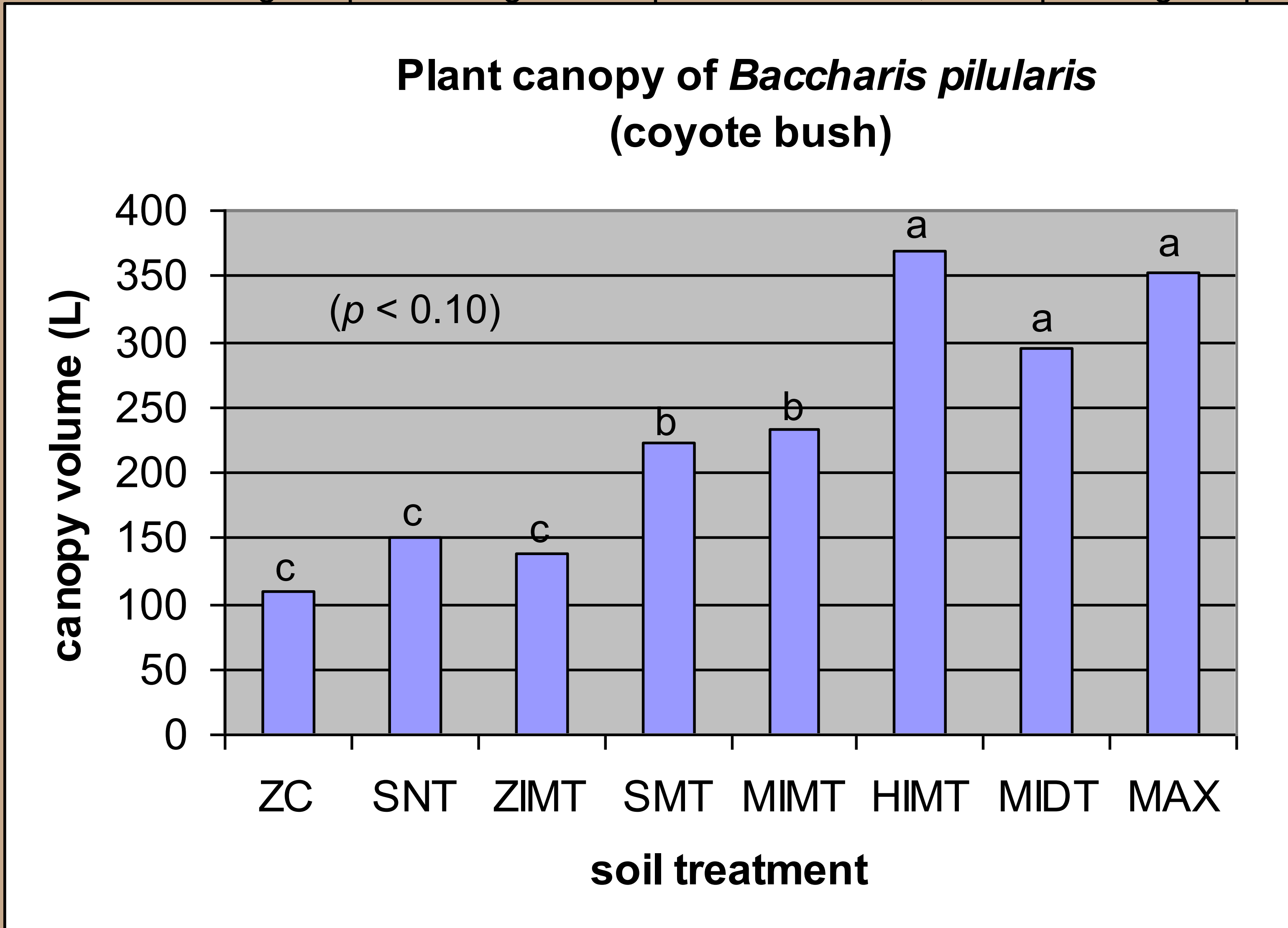
Third season growth: plants are established with no irrigation, although some plants died in plots with no soil amendment.

View along slope, showing purple needlegrass on the lower half of each plot and coyote bush on the upper half of each plot.

A view of the plots with the best plant growth (deep incorporation of compost).

A view of the plots with the smallest surviving plants (no tillage).

Finding: Canopy growth of plants at 85 x 17. The greatest growth occurred in plots with medium tillage depth and higher compost amendment, or deeper tillage depths.

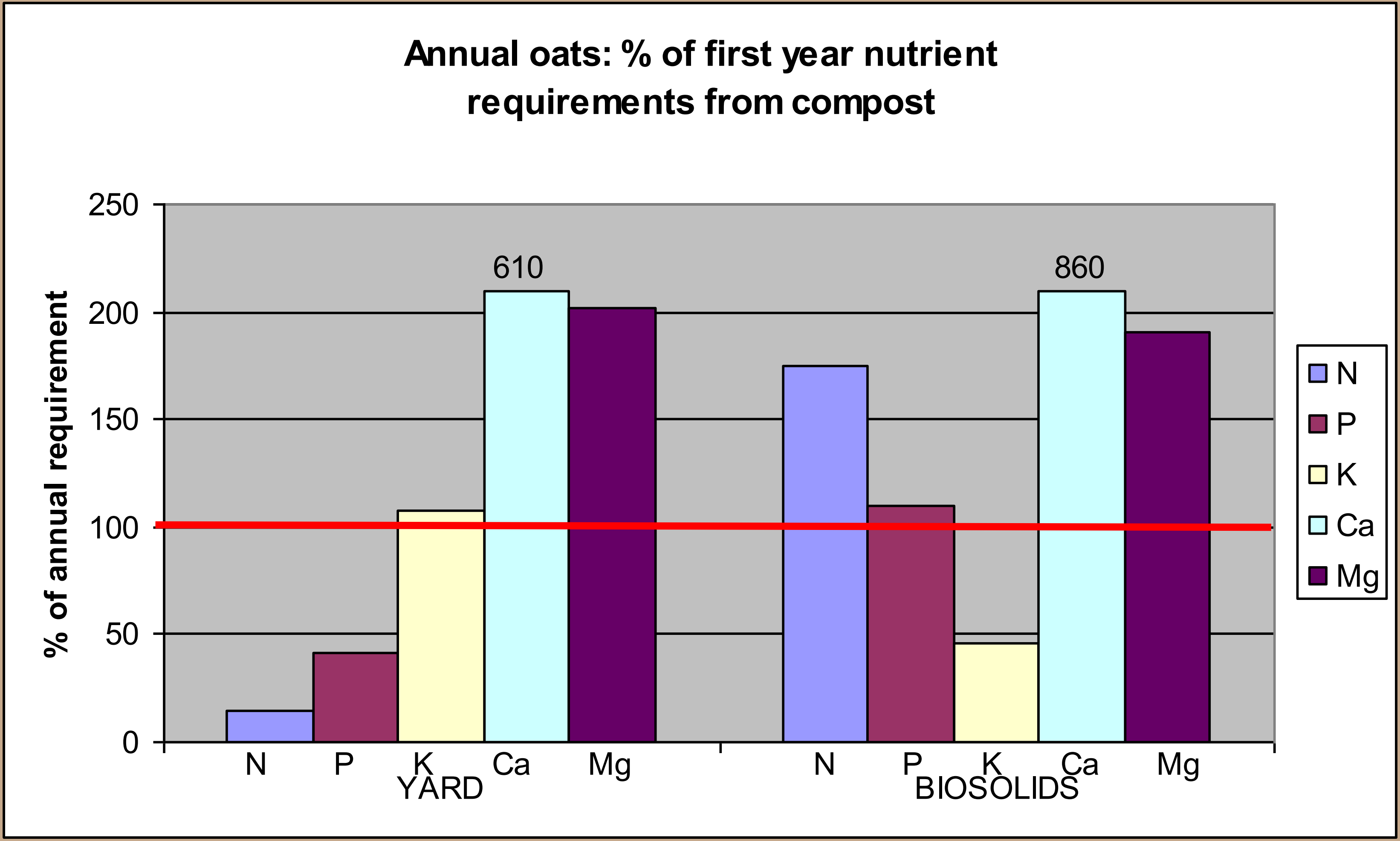


treatments:	ZC	SNT	ZIMT	SMT	MIMT	HIMT	MIDT	MAX
	zero till no comp	surf comp no till	med till no incorp	shallow incorp med till	med incp med till	high org amount med till	med incp deep till (3 feet)	high org amount inorganic moist retainer deep tillage (3 feet)

The previous slide is a bar chart showing the canopy growth of coyote bush plants at the site

- y-axis: Canopy volume in liters from 0 to 400
- x-axis: Soil treatments: Zero till no compost, surface compost no till, medium till no incorporation, shallow incorporation medium till, medium incorporation medium till, high organic amount medium till, medium incorporation deep till (3 feet), high organic amount inorganic moist retainer deep till (3 feet)
  - First 3 treatments, second 2 treatments and last 3 treatments are not statistically different at p less than 0.1
- The greatest growth occurred in plots with medium tillage depth and higher compost amendment, or deeper tillage depths.

Nutrient release from large compost applications should match plant uptake rates so that leachates do not impact the watershed. How do plant uptake requirements and compost nutrient releases compare? Using annual grasses as a model community, only calcium and magnesium exceed plant uptake from yard waste compost. From biosolids materials, nitrogen, calcium and magnesium exceeded plant uptake rates.



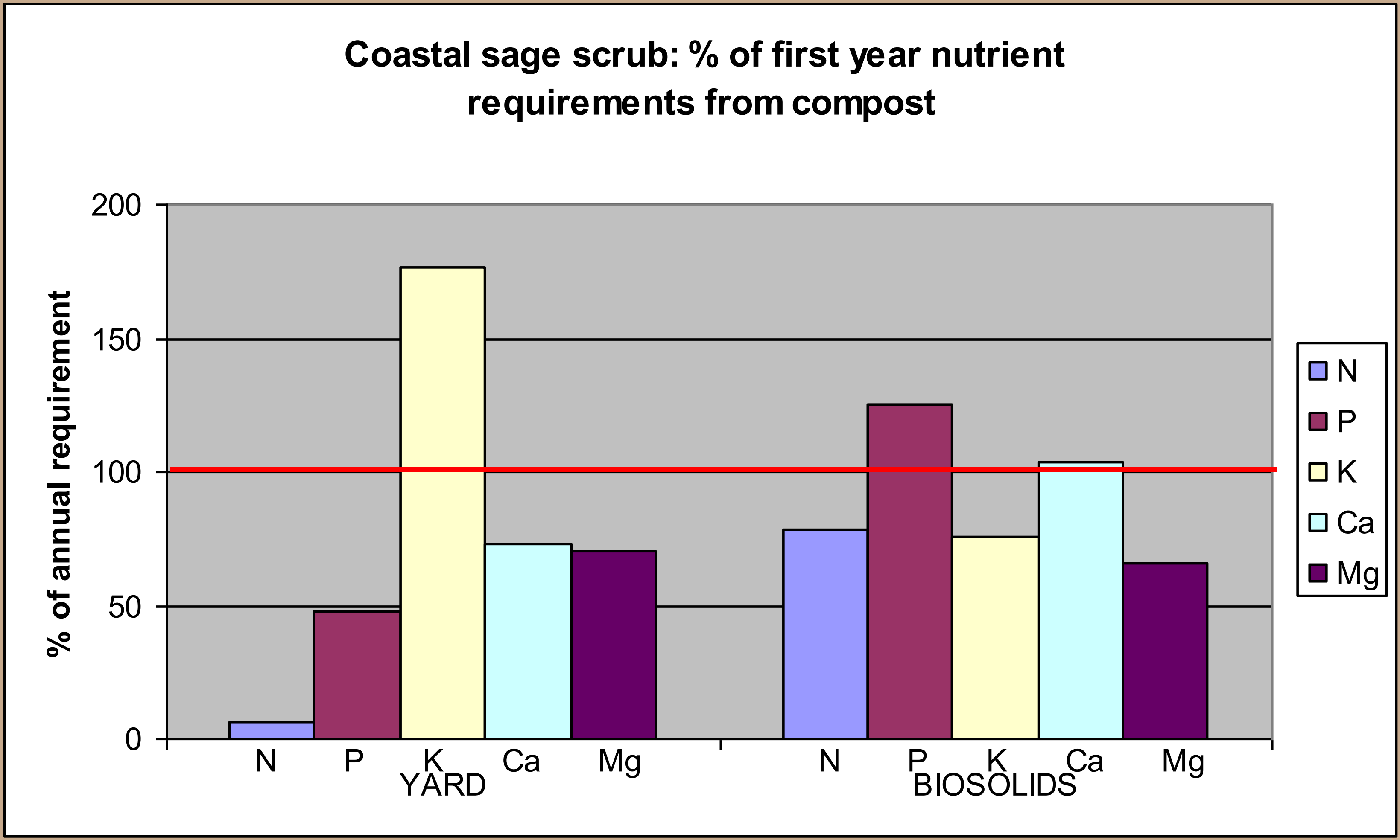
The previous slide is a bar chart showing percent of first year nutrient requirements of annual oats provided by compost.

- y-axis: percent of annual requirement from 0 to 250 with a line across graph at 100
- x-axis: N, P, K, Ca and Mg bars for Yard and Biosolids

For Yard – Mg and Ca bars are around 200 percent, K is around 100 percent, P is around 45 percent and N is around 15 percent

For Biosolids – Ca and Mg bars are around 200 percent, N is around 175 percent, P is around 100 percent and K is around 50 percent.

Using data from a first year, perennial coastal sage scrub community, only potassium is released from yard waste compost faster than plant uptake rates, while biosolids release P faster than plant uptake. Leachate salts are mainly in the form of nutrients that are incorporated into plant tissue.



The previous slide is a bar chart showing percent of first year nutrient requirements of coastal sage scrub provided by compost.

- y-axis: percent of annual requirement from 0 to 200 with a line across graph at 100
- x-axis: N, P, K, Ca and Mg bars for Yard and Biosolids

For Yard – K bar is around 175 percent, Mg and Ca are around 75 percent, P is around 50 percent and N is around 10 percent

For Biosolids – P bar is around 125 percent, Ca is around 100 percent, N and K are around 75 percent and Mg is at 60 percent.

general list of functions of ‘organics’

soil function	influenced by:
water	
+ infiltration rate	coarse woody frags, unscreened compost
+ infiltration amount	depth of incorporation
+ water retention	only at wet end, use for increased rooting
+ ease of rooting	prevent hardsetting
+ soil aggregation	organic coatings, microbial decomposition
+ reduce evaporation	shading (wood fragments or fines)
	mulch layer (thickness)
	soil properties (depends on texture, cracking)
nutrients	
+ quick green up	compost tea, finest fractions
+ faster, moderate nutrient rel.	more cured compost
+ low, slow nutrient release	less cured compost
+ adsorb atm N deposition	less cured, with decomposable organics
+ community regeneration	large amount of stabilized organics applied

Conclusion:

Water infiltration and fertility on harsh degraded sites can be improved by soil treatment with yard waste composts and deep tillage, if the substrate is not already rootable to about 3 feet. At many sites, no irrigation of native plants is required.